



Lightning Imaging Sensor on International Space Station

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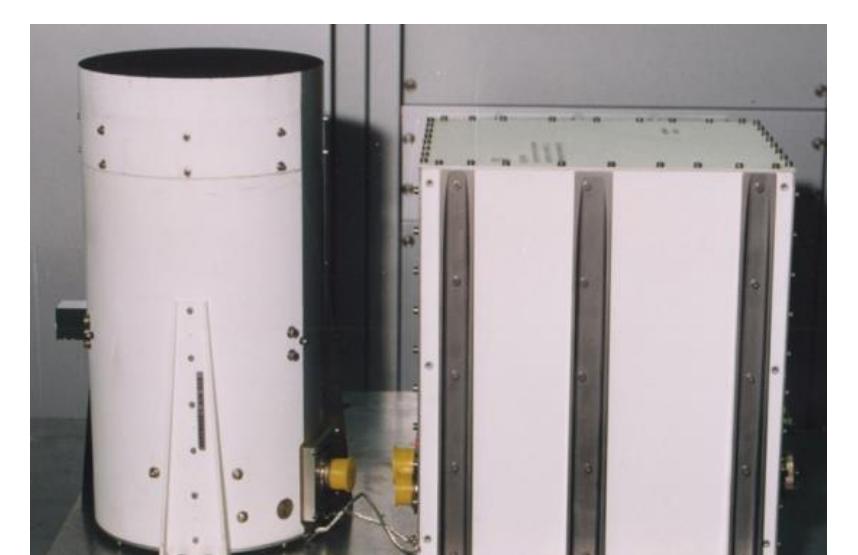


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Introduction and Overview

Mission

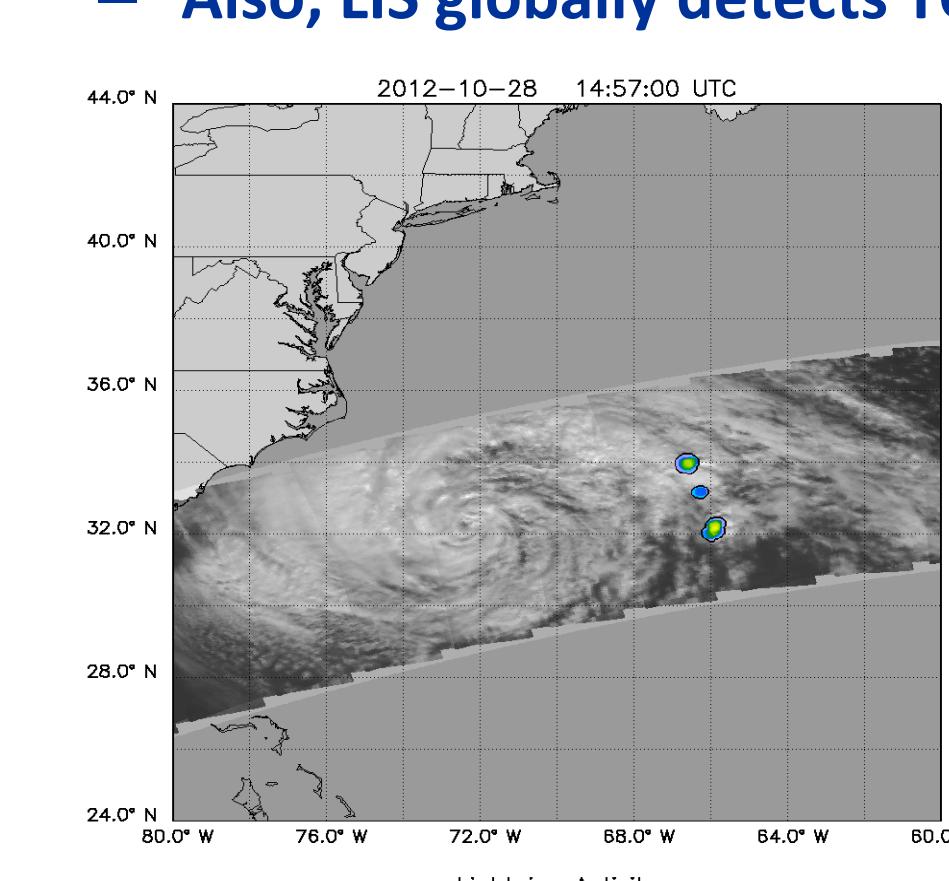
- Fly a space-qualified, flight-spare LIS on ISS to take advantage of unique capabilities provided by the ISS (e.g., *high inclination, real time data*).
- Integrate LIS as a hosted payload on the DoD Space Test Program-Houston 5 (STP-H5) mission and launch on a Space X rocket in June 2016 for a minimum 2 year mission.



Flight Spare LIS

Measurement

- NASA and its partners developed and demonstrated effectiveness and value of space-based lightning observations as a remote sensing tool.
- LIS measures total lightning (*amount, rate, radiant energy*) during both day and night, with storm scale resolution, millisecond timing, and high, detection efficiency.
 - LIS daytime detection is especially unique and scientifically important (>70% occurs during day).
 - Also, LIS globally detects TOTAL (both cloud and ground) lightning with no land-ocean bias.



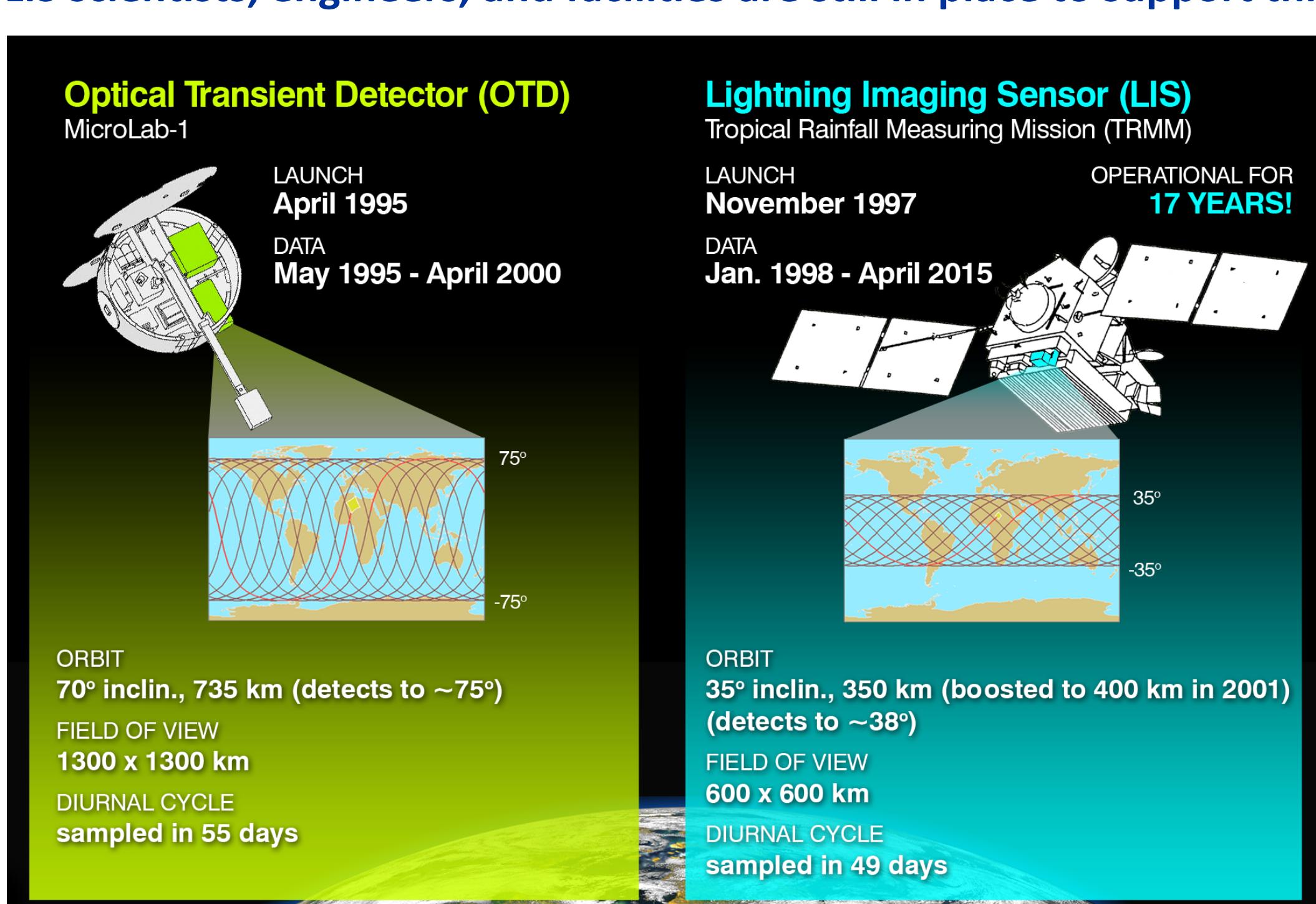
LIS Lightning and Background Images
(Super Storm Sandy October 28, 2012)

Need and Benefit

- Lightning is quantitatively coupled to both thunderstorm and related geophysical processes, and therefore provides important science inputs across a wide range of disciplines (e.g., *weather, climate, atmospheric chemistry, lightning physics*).
- LIS on ISS will extend TRMM time series observations, expand latitudinal coverage, provide real time data to operational users, and enable cross-sensor calibration.

LIS Heritage (Flight, Infrastructure, Hardware)

- ISS LIS builds upon a solid foundation of 20 years on-orbit observations.
- Key LIS scientists, engineers, and facilities are still in place to support this mission.



Sensor Unit (legacy hardware)

- Optical Assembly
- 128x128 CCD Focal Plane
- Lightning and Background detection

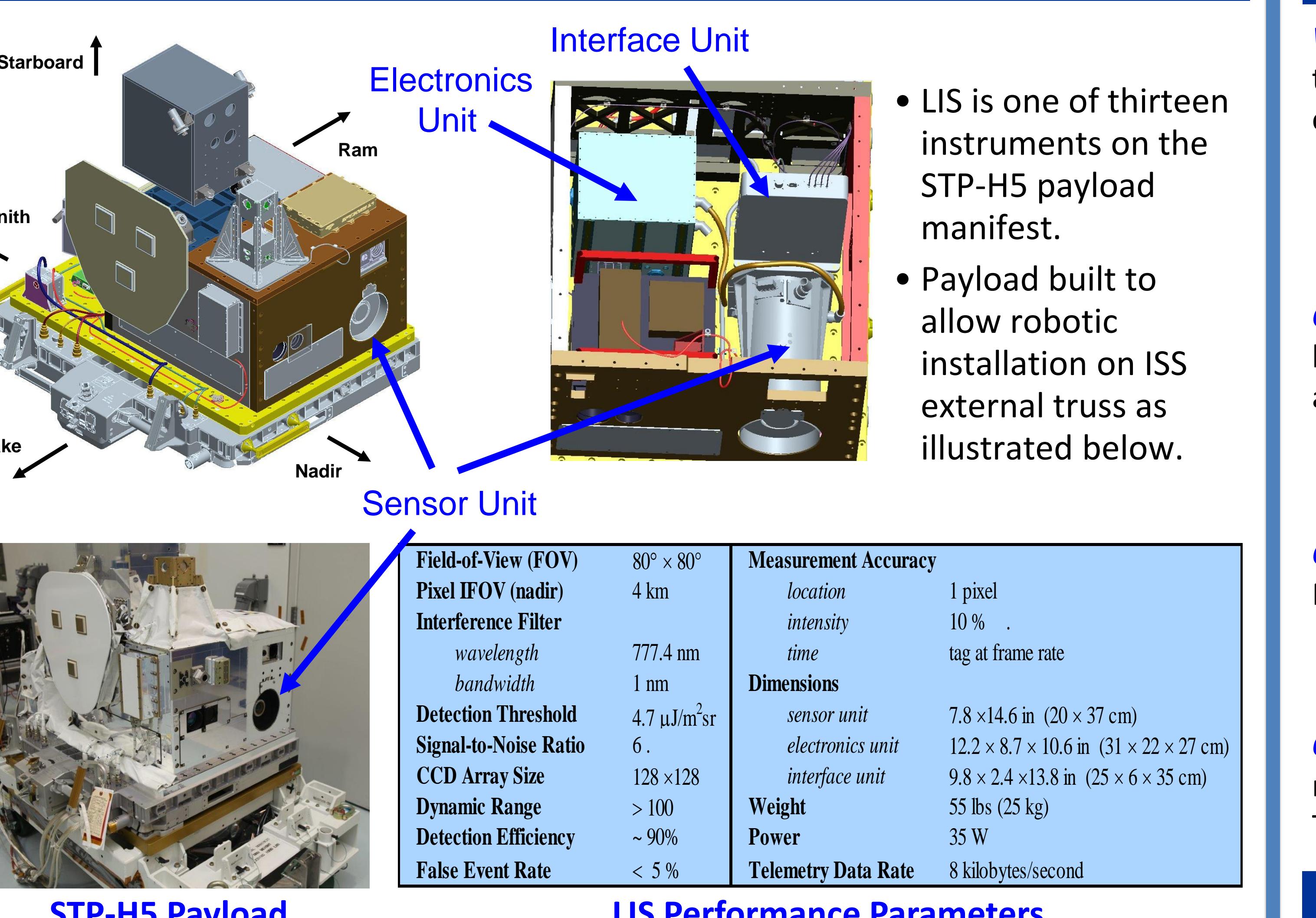
Electronics Unit (legacy hardware)

- Real Time Event Processor, Background removal, Data formatting
- Power conversion and control

Interface Unit (new hardware)

- Power conversion, Timing, Control
- ISS Interface

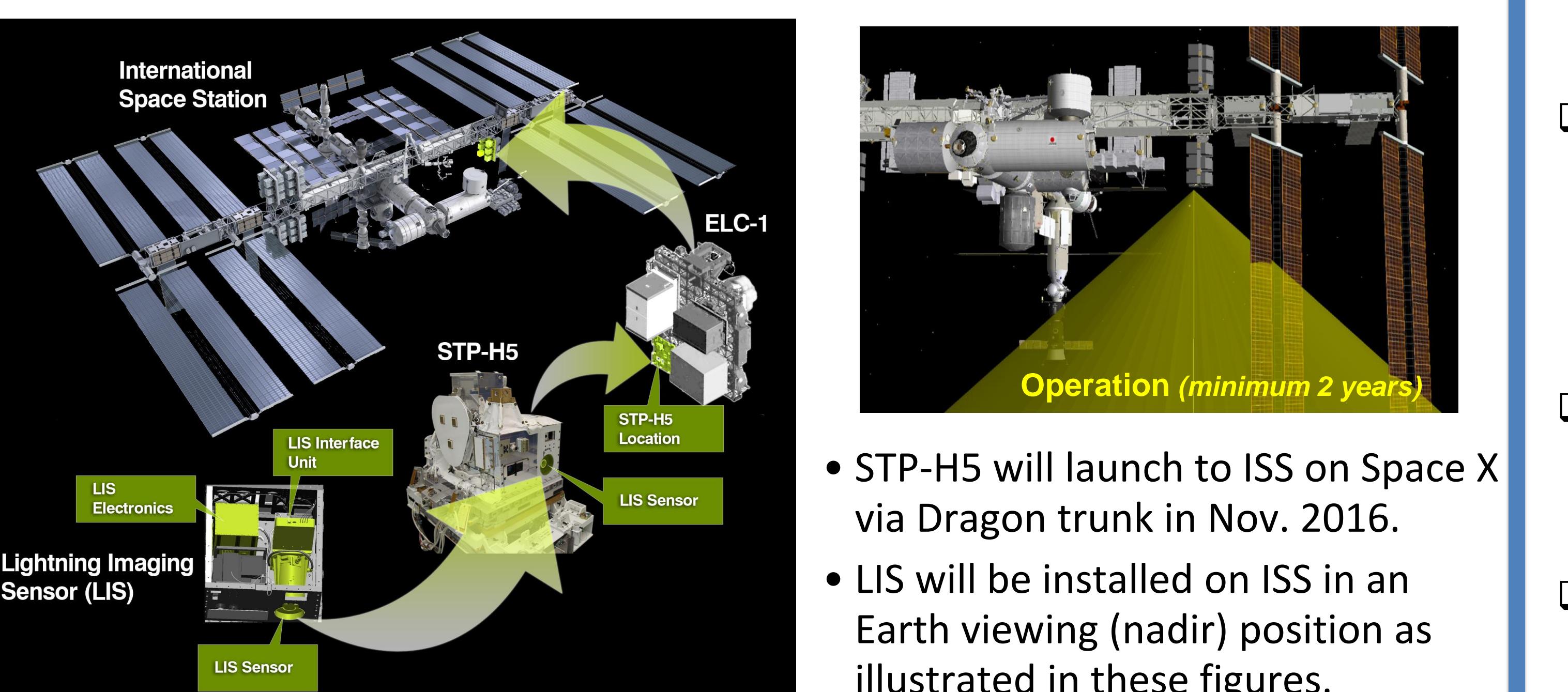
LIS Integration as Hosted Payload on STP-H5



STP-H5 Payload

LIS Performance Parameters

LIS Launch and Installation Scenario

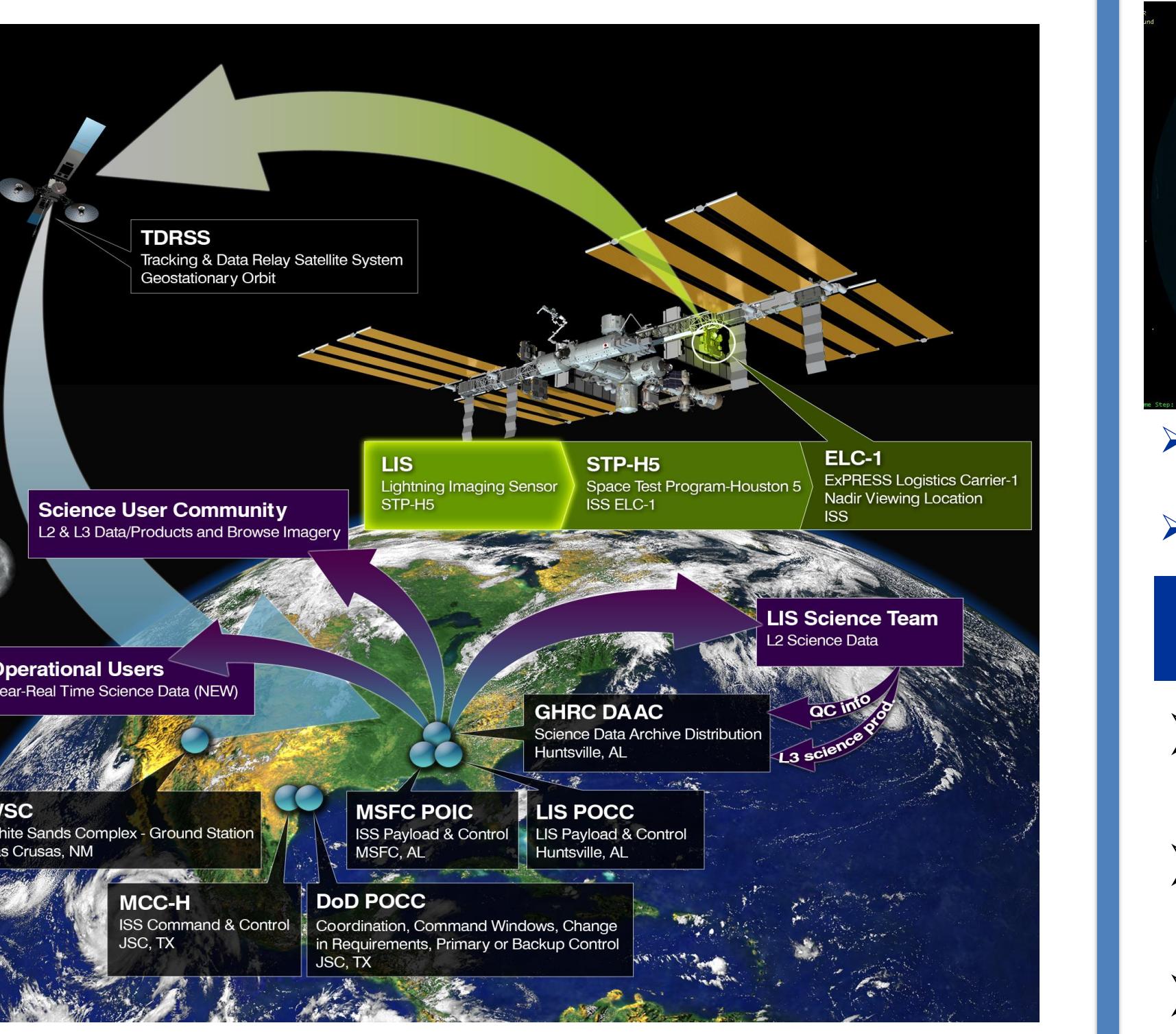


- STP-H5 will launch to ISS on Space X via Dragon trunk in Nov. 2016.
- LIS will be installed on ISS in an Earth viewing (nadir) position as illustrated in these figures.

Science Operations and Data Management



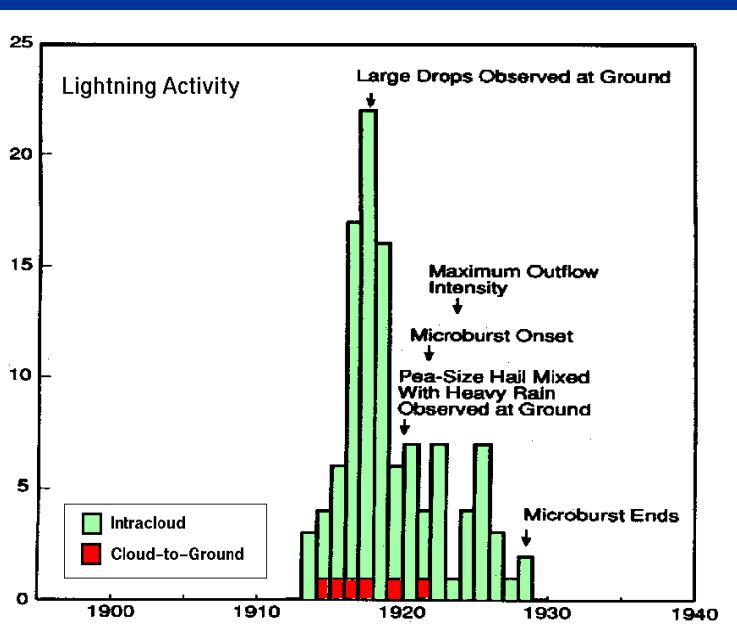
- Science operations will be managed from newly established LIS POCC.
- Data handling involves close partnership between LIS Science Team and GHRC DAAC.



Science and Applications from LIS Lightning

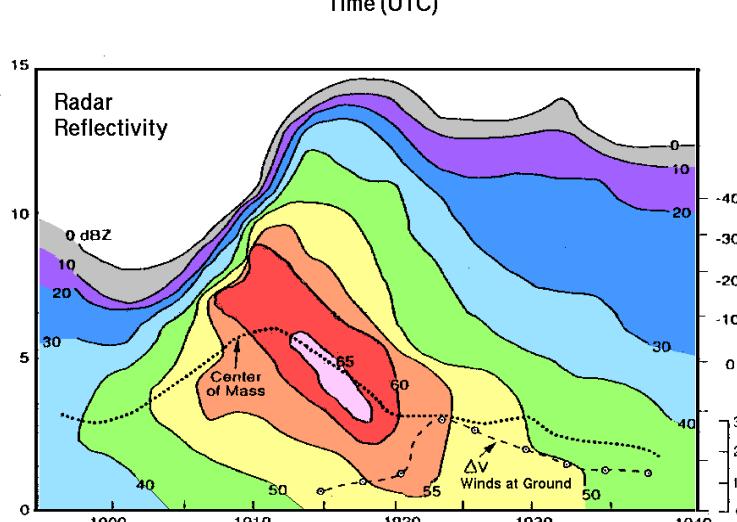
Weather: Total lightning is strongly coupled in a quantitative way to thunderstorm processes and responds to updraft velocity and cloud particles (concentration, phase, type, and flux).

- LIS acts like a radar in space: it reveals the heart of the cloud.
- Lightning can improve convective precipitation estimates.
- Lightning is strongly coupled to severe weather hazards (*winds, floods, tornadoes, hail, wild fires*) and can improve forecast models.



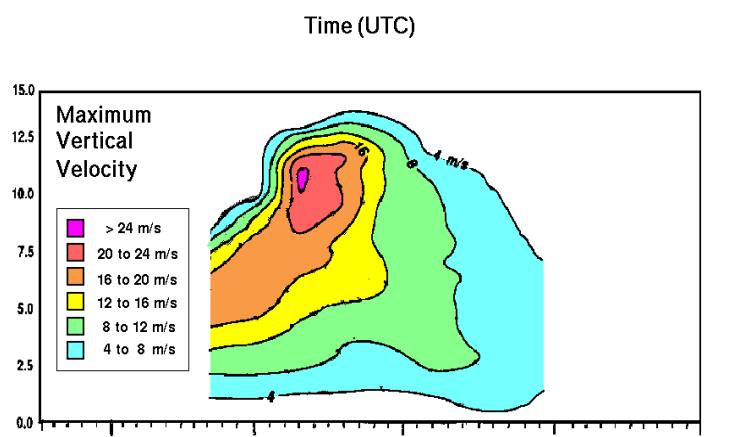
Climate: Lightning is an excellent variable for climate monitoring because it is sensitive to small changes in temperature and atmospheric forcing. ISS LIS will:

- Extend 16 year time series of TRMM LIS, expand to higher latitudes.
- Monitor the occurrence and changes in extreme storms.
- Provide much desired cross-sensor calibrations between platforms.



Chemistry: ISS LIS will help improve estimates of lightning produced NO_x for climate and air quality studies.

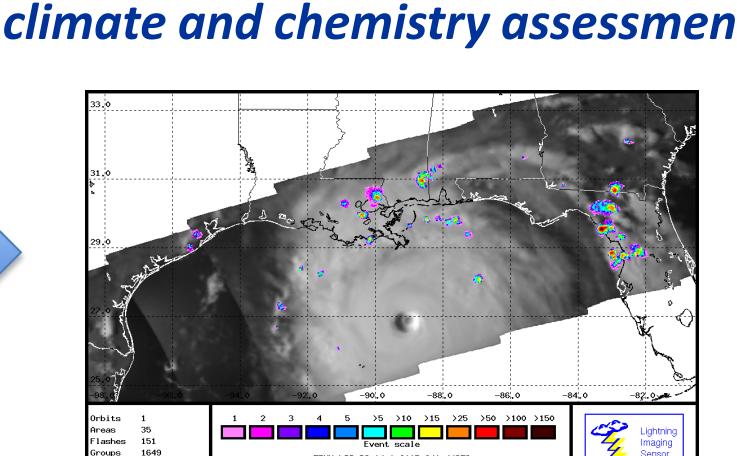
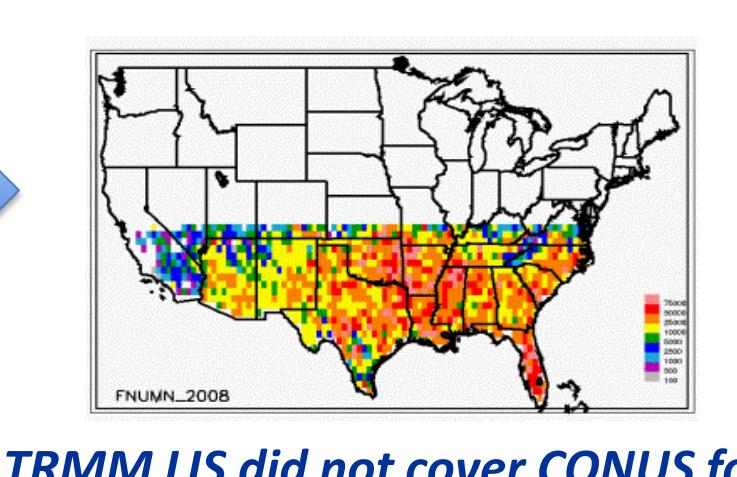
- Lightning NO_x also impacts ozone, an important green house gas.
- Climate most sensitive to ozone in upper troposphere, exactly where lightning is the most important source of NO_x.



Other: Complementary ISS LIS observations will help unravel the mechanisms leading to terrestrial gamma-ray flashes (TGFs) and Transient Luminous Events (TLEs).

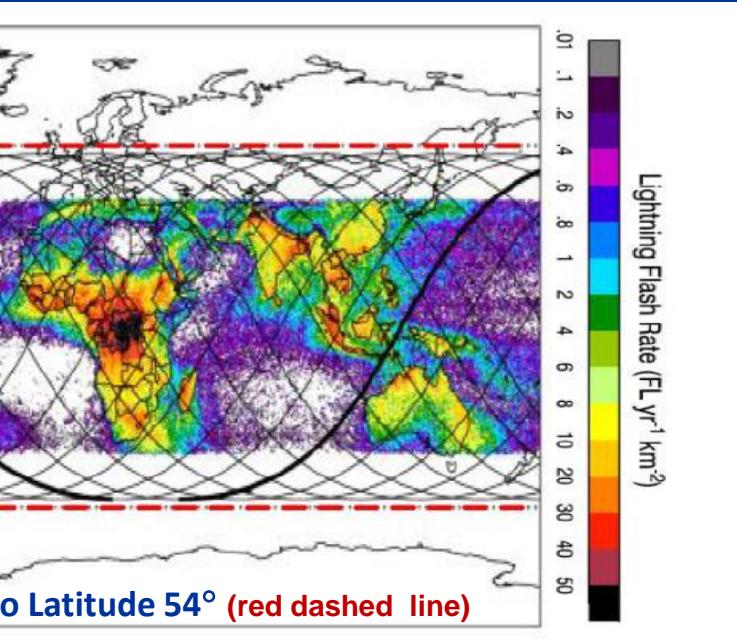
Unique Science Contributions from ISS Platform

- Lightning coverage at higher latitudes missed by TRMM
 - TRMM LIS missed up to 30% lightning in N. Hemisphere summer
 - Enhance regional and global weather, climate, and chemistry studies
 - Provide CONUS coverage (needed for the National Climate Assessment).
- Real time lightning using ISS for operational applications
 - Provide real time lightning in data sparse regions, especially oceans (storm warnings, nowcasts, oceanic aviation support, long- range lightning system validation, hurricane rapid intensification evaluations).
 - Desired by NASA and strongly endorsed by NOAA partners (partners include: NWS Pacific Region, Joint Typhoon Warning Center, Ocean Prediction Center, Aviation Weather Center, and National Hurricane Center).
- Enable simultaneous / complementary observations with other ISS payloads
 - Provide critical daytime lightning to better understand mechanisms leading to TGFs and TLEs (strongly endorsed by ESA ASIM).
- Support cross-sensor calibration and validation activities
 - Inter-calibrate ISS LIS with GOES-R GLM and MTG LI for improved science and applications (strongly endorsed by NOAA and ESA).



Global Coverage of LIS on ISS

- 3D and 2D simulations of ISS LIS orbit and footprint using the STK orbit tracking and planning tool.
- This tool is used in the LIS Payload Operations Control Center.
- ISS LIS orbit overlaid on TRMM LIS Data.
- ISS LIS will detect 98% of lightning on annual basis (versus 90% for TRMM LIS).



Summary

- LIS on ISS will continue the cross-disciplinary support of high-value science and applications begun with OTD and LIS on TRMM.
- The project will leverage data-handling infrastructure from TRMM to quickly deliver high-quality LIS data to users once operations begin
- LIS remains the "gold standard" for understanding global lightning climatology.